Figure 1

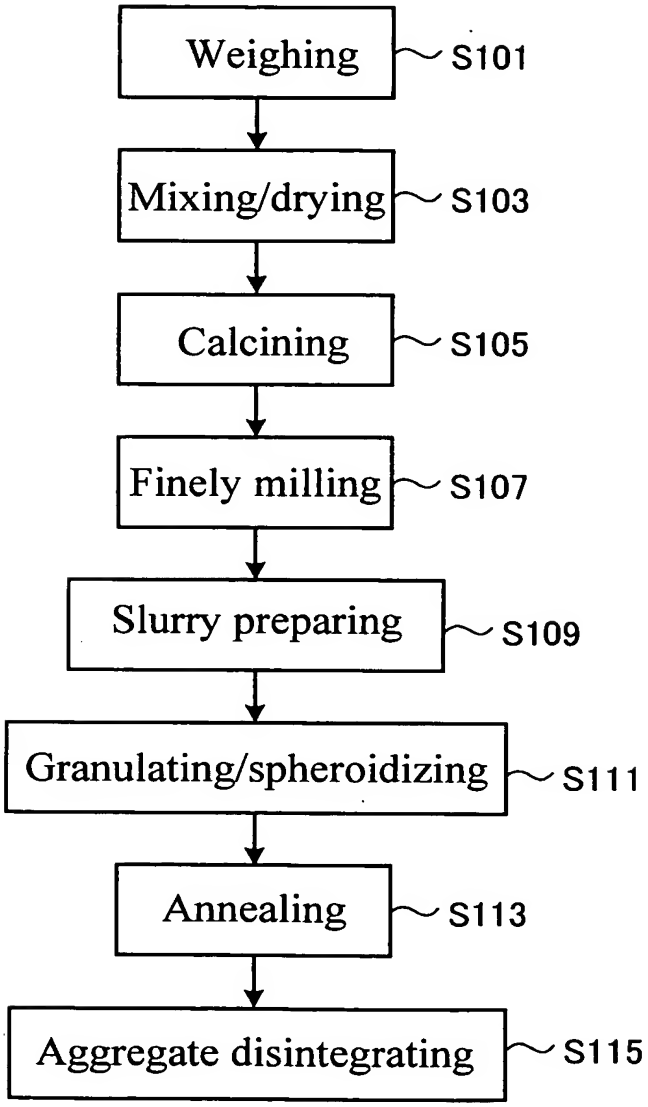

Weighing
S101
Mixing/drying
S103
Calcining
S105
Finely milling
S107
Slurry preparing
S109
Granulating/spheroidizing
S111
Annealing
S113
Aggregate disintegrating
S115

Figure 2

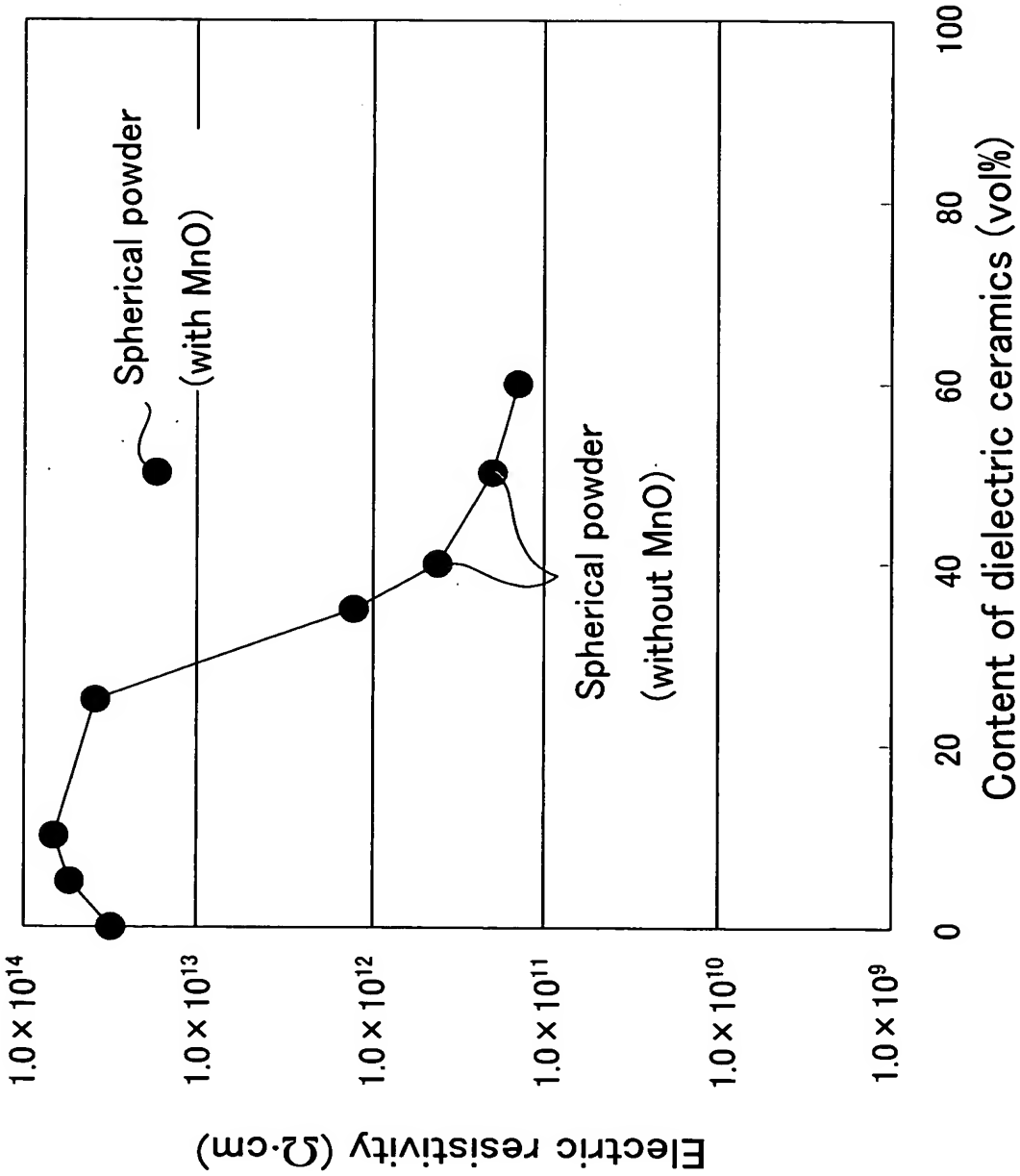
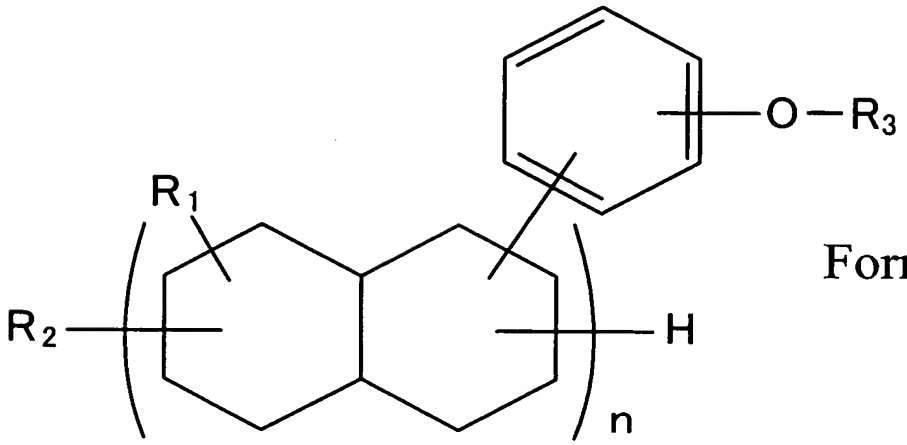

Spherical powder
(with MnO)
Spherical powder
(without MnO)
Electric resistivity (Ω·cm)
1.0×10^14
1.0×10^13
1.0×10^12
1.0×10^11
1.0×10^10
1.0×10^9
0
20
40
60
80
100
Content of dielectric ceramics (vol%)

Figure 3



Formula (1)

Figure 4

R_1	R_2	R_3 H : vinylbenzyl (molar ratio)	n
methyl	benzyl	0:100	3
methyl	benzyl	5:95	3
methyl	benzyl	60:40	3
methyl	benzyl	40:60	3
methyl	benzyl	20:80	3

Figure 5

	Additive	Addition amount (wt%)	Annealing (°C)	Dielectric properties (at 2 GHz)		Insulation resistance	Remarks
				ε	Q	Electric resistivity (Ω·cm)	
Example 1	$MnCO_3$	0.15	1000	10.71	304	5.5×10^{13}	Added to/mixed with finely milled powder
Comparative Example 1	Bi_2O_3	1.0	1000	14.43	290	4.5×10^{11}	Added to/mixed with finely milled powder
Comparative Example 2	SiO_2	1.0	1000	11.36	335	2.9×10^{11}	Added to/mixed with finely milled powder
Comparative Example 3	$CaCO_3$	1.0	1000	11.85	270	2.0×10^{11}	Added to/mixed with finely milled powder
Comparative Example 4	None	—	1000	9.33	312	3.1×10^{10}	-

Figure 6

	Additive	Addition amount (wt%)	Annealing (°C)	Dielectric properties (at 2 GHz)		Insulation resistance	Remarks
				ε	Q	Electric resistivity (Ω·cm)	
Example 2	$MnCO_3$	0.15	1100	12.10	355	9.9×10^{13}	Added to/mixed with finely milled powder
Example 1	$MnCO_3$	0.15	1000	10.71	304	5.5×10^{13}	Added to/mixed with finely milled powder
Comparative Example 5	Bi_2O_3	1.0	1100	13.17	368	2.6×10^{11}	Added to/mixed with finely milled powder
Comparative Example 1	Bi_2O_3	1.0	1000	14.43	290	4.5×10^{11}	Added to/mixed with finely milled powder
Comparative Example 6	SiO_2	1.0	1100	10.80	365	1.4×10^{12}	Added to/mixed with finely milled powder
Comparative Example 2	SiO_2	1.0	1000	11.36	335	2.9×10^{11}	Added to/mixed with finely milled powder
Comparative Example 7	$CaCO_3$	1.0	1100	11.92	310	1.4×10^{11}	Added to/mixed with finely milled powder
Comparative Example 3	$CaCO_3$	1.0	1000	11.85	270	2.0×10^{11}	Added to/mixed with finely milled powder
Comparative Example 8	None	–	1100	11.58	359	2.6×10^{10}	–
Comparative Example 4	None	–	1000	9.33	312	3.1×10^{10}	–

Figure 7

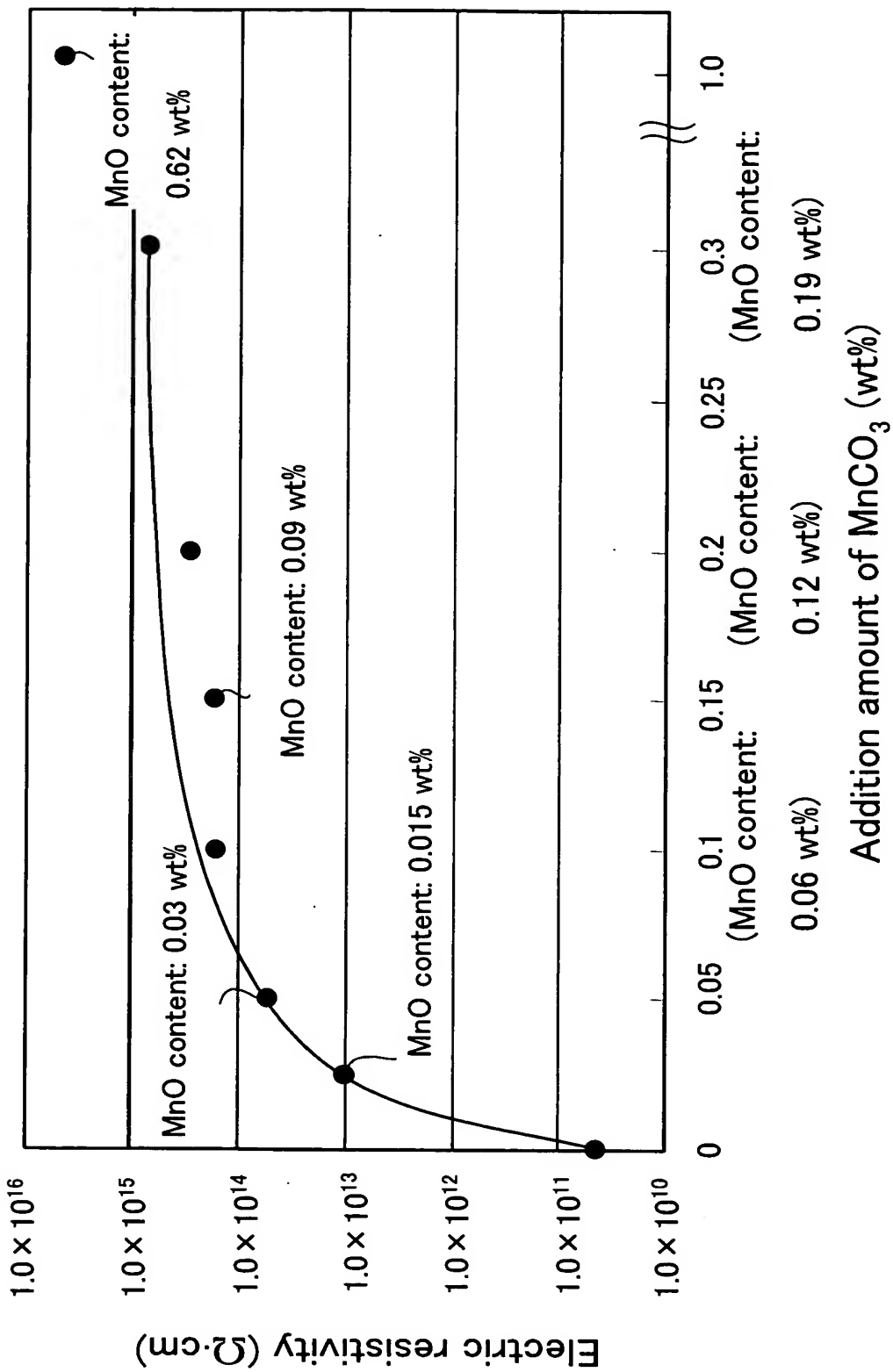

Electric resistivity (Ω·cm)
1.0 × 10^16
1.0 × 10^15
1.0 × 10^14
1.0 × 10^13
1.0 × 10^12
1.0 × 10^11
1.0 × 10^10
MnO content: 0.62 wt%
MnO content: 0.09 wt%
MnO content: 0.03 wt%
MnO content: 0.015 wt%
0
0.05 (MnO content: 0.06 wt%)
0.1 (MnO content: 0.12 wt%)
0.15
0.2 (MnO content: 0.19 wt%)
0.25
0.3 (MnO content:
1.0
Addition amount of MnCO3 (wt%)

Figure 8A

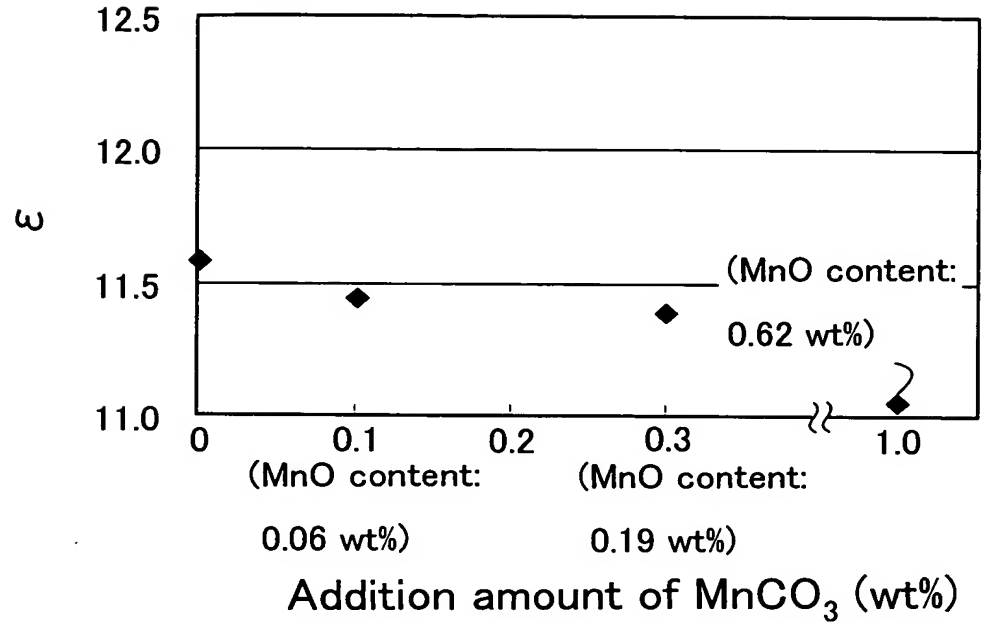


Figure 8B

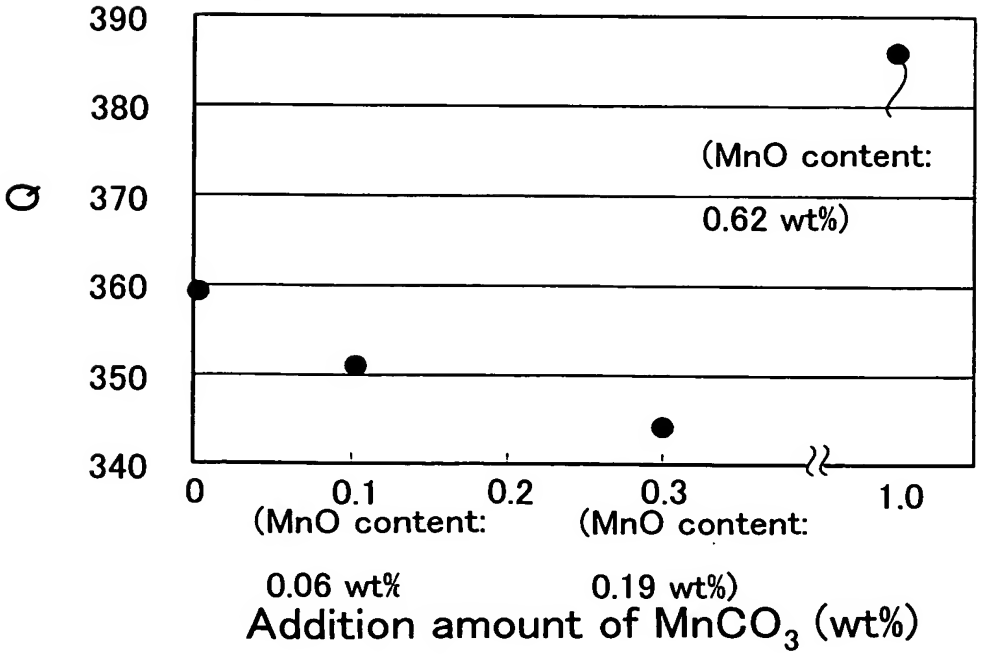


Figure 9A

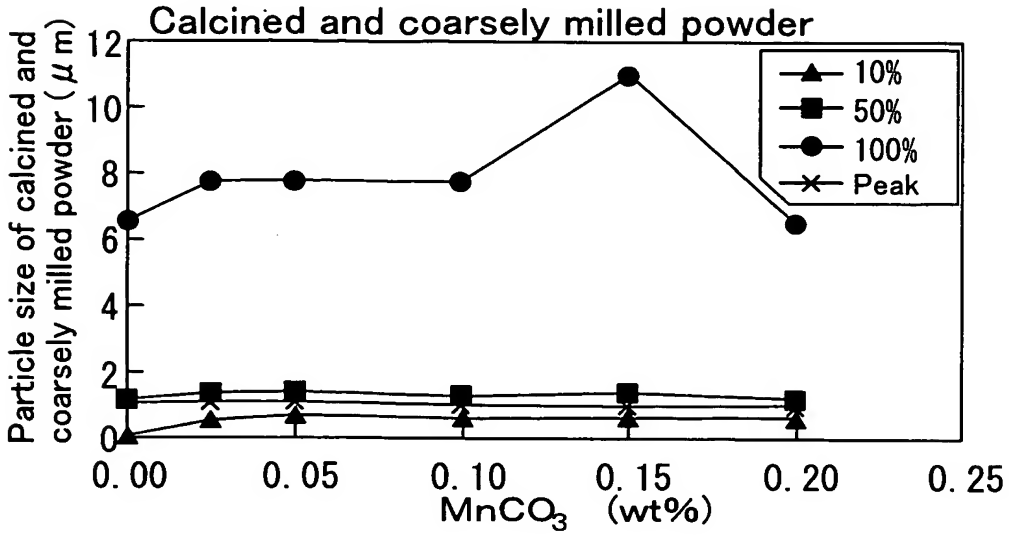


Figure 9B

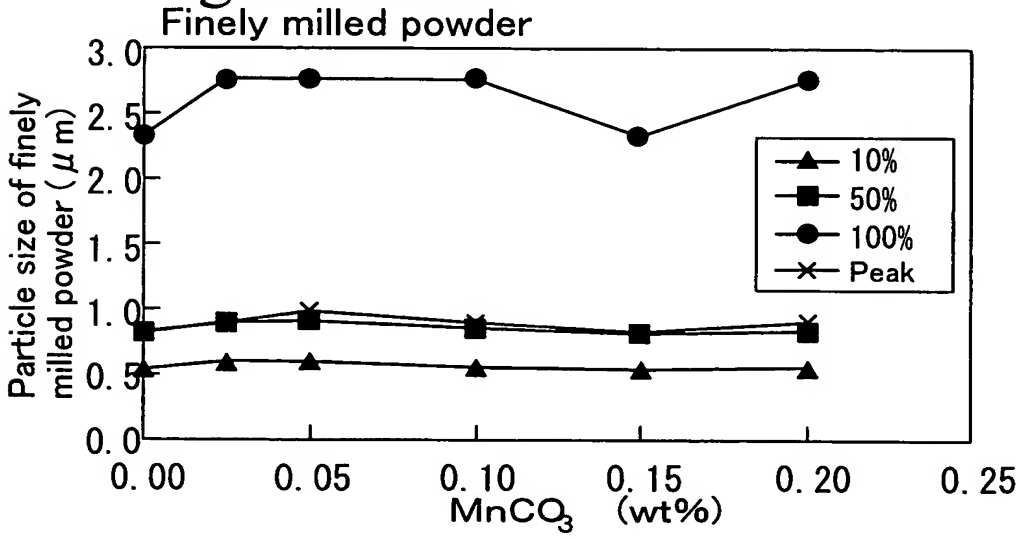


Figure 9C

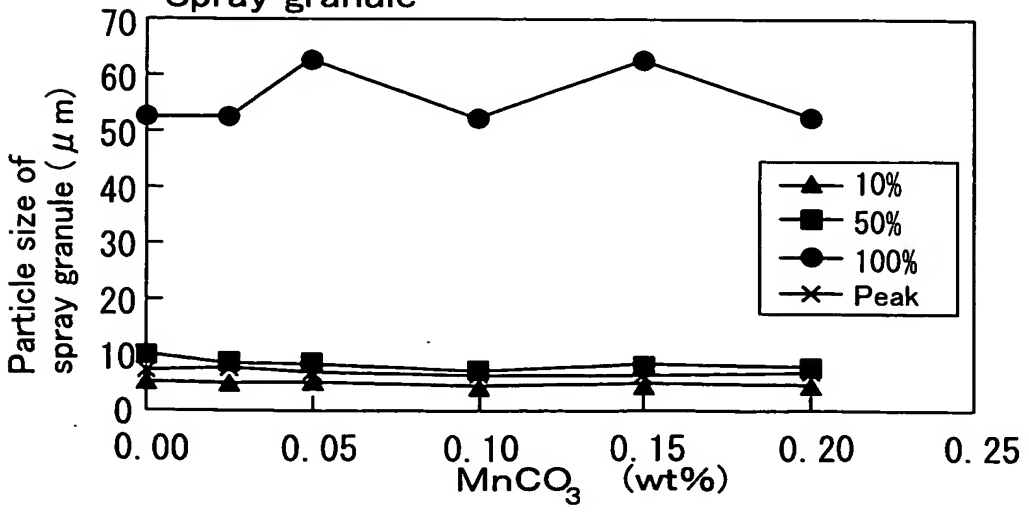


Figure 10A

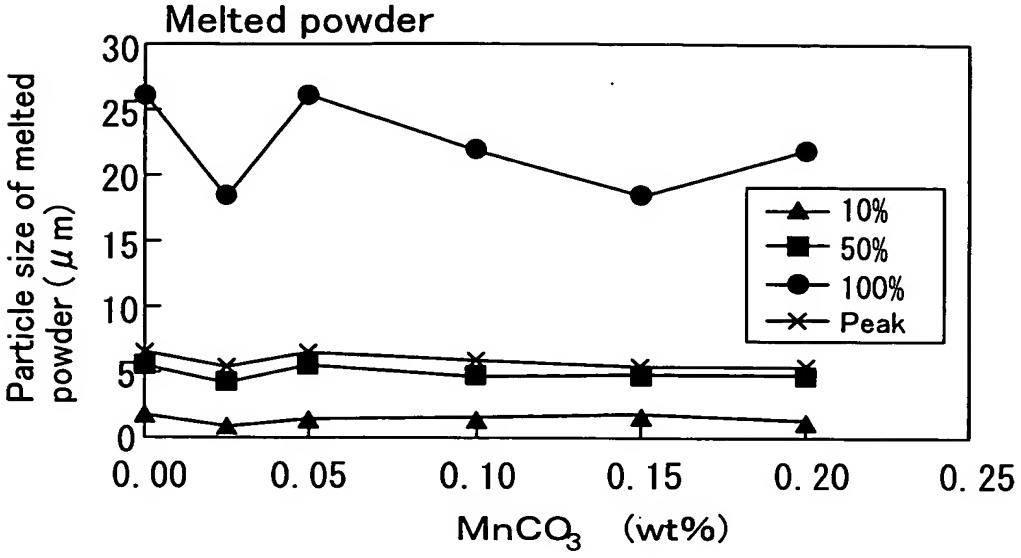


Figure 10B

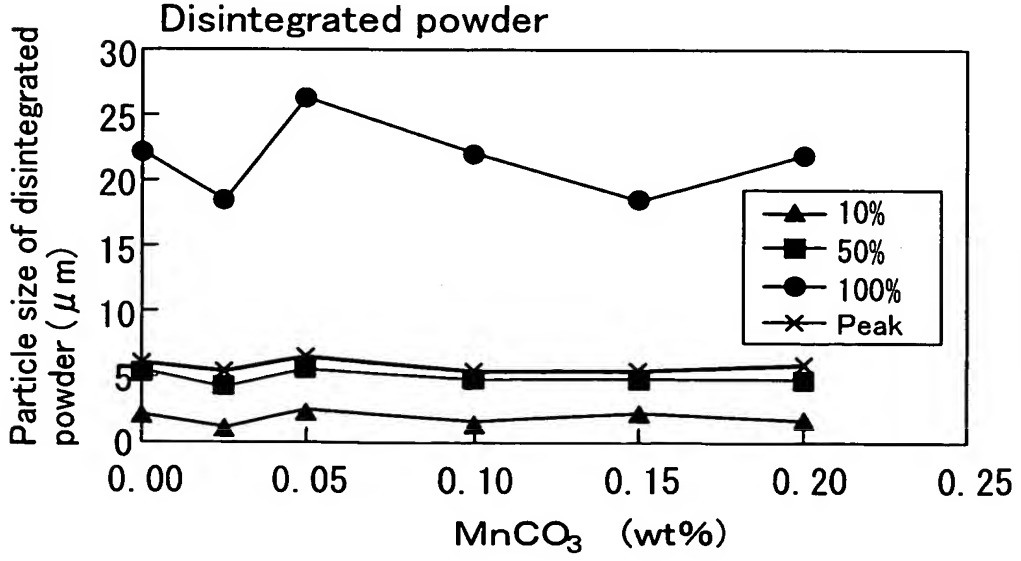


Figure 11

Additive	Addition amount (wt%)	Annealing (°C)	Dielectric properties (at 2 GHz)		Insulation resistance	Remarks
			ε	Q	Electric resistivity (Ω·cm)	
$MnCO_3$	0.05	1100	11.73	354	2.7×10^{13}	Added to/mixed with finely milled powder
$MnCO_3$	0.10	1100	11.44	351	3.4×10^{13}	Added to/mixed with finely milled powder
$MnCO_3$	0.15	1100	12.10	355	9.9×10^{13}	Added to/mixed with finely milled powder
$MnCO_3$	0.20	1100	11.47	352	4.6×10^{13}	Added to/mixed with finely milled powder

Figure 12

Additive	Addition amount (wt%)	Annealing (°C)	Dielectric properties (at 2 GHz)		Insulation resistance	Remarks
			ε	Q	Electric resistivity (Ω·cm)	
$MnCO_3$	0.05	1150	12.18	363	2.6×10^{13}	Added to/mixed with finely milled powder
$MnCO_3$	0.10	1150	12.07	359	2.2×10^{13}	Added to/mixed with finely milled powder
$MnCO_3$	0.15	1150	12.21	358	3.3×10^{13}	Added to/mixed with finely milled powder
$MnCO_3$	0.20	1150	11.64	347	2.4×10^{13}	Added to/mixed with finely milled powder

Figure 13

	Composition (wt%)					Additive (wt%)	Powder type	Sphe-ricity	Specific surface area (m^2/g)	Electric resistivity ($\Omega \cdot cm$)	Remarks
	BaO	Nd_2O_3	TiO_2	Bi_2O_3	MnO						
1	18.93	41.19	39.88	–	–	–	Spherical powder	0.97	0.459	7.7×10^{10}	Without MnO in final composition
2	18.93	41.19	39.88	–	–	–	Spherical powder	0.98	3.436	5.1×10^{10}	Without MnO in final composition
3	18.93	41.19	39.88	–	–	–	Spherical powder	0.85	2.688	1.0×10^{11}	Without MnO in final composition
4	16.6	38.86	41.7	–	–	–	Spherical powder	0.92	3.097	6.1×10^{12}	Without MnO in final composition
5	18.93	41.19	39.88	–	–	–	Spherical powder	0.88	1.824	5.8×10^{9}	Without MnO in final composition
6	18.93	41.19	39.88	–	–	–	Spherical powder	0.99	1.702	5.3×10^{10}	Without MnO in final composition
7	18.93	41.19	39.88	–	–	–	Spherical powder	0.92	2.097	6.1×10^{10}	Without MnO in final composition
8	18.93	41.19	39.88	–	–	–	Spherical powder	0.83	1.570	1.1×10^{11}	Without MnO in final composition
9	18.93	41.19	39.88	–	–	–	Spherical powder	0.81	2.235	3.1×10^{11}	Without MnO in final composition
10	18.93	41.19	39.88	–	–	–	Spherical powder	0.96	2.092	2.0×10^{11}	Without MnO in final composition
11	18.93	41.19	39.88	–	–	–	Crushed powder	0.72	1.600	4.3×10^{13}	Without MnO in final composition
12	18.93	41.19	39.88	–	–	–	Crushed powder	0.63	1.819	3.1×10^{13}	Without MnO in final composition
13	18.93	41.19	39.88	–	–	–	Spherical powder	0.94	0.465	2.6×10^{10}	Without MnO in final composition
14	18.93	41.19	39.88	–	–	Bi_2O_3 0.15	Spherical powder	0.87	0.798	2.6×10^{11}	Without MnO in final composition
15	16.6	38.86	41.7	2.751	0.088	–	Crushed powder	0.61	1.617	4.7×10^{13}	With MnO in final composition
16	16.6	38.86	41.7	2.751	0.088	–	Spherical powder	0.83	0.426	4.5×10^{13}	With MnO in final composition
17	18.93	41.19	39.88	–	–	$MnCO_3$ 0.15	Spherical powder	0.90	0.454	9.9×10^{13}	With MnO in final composition

Figure 14

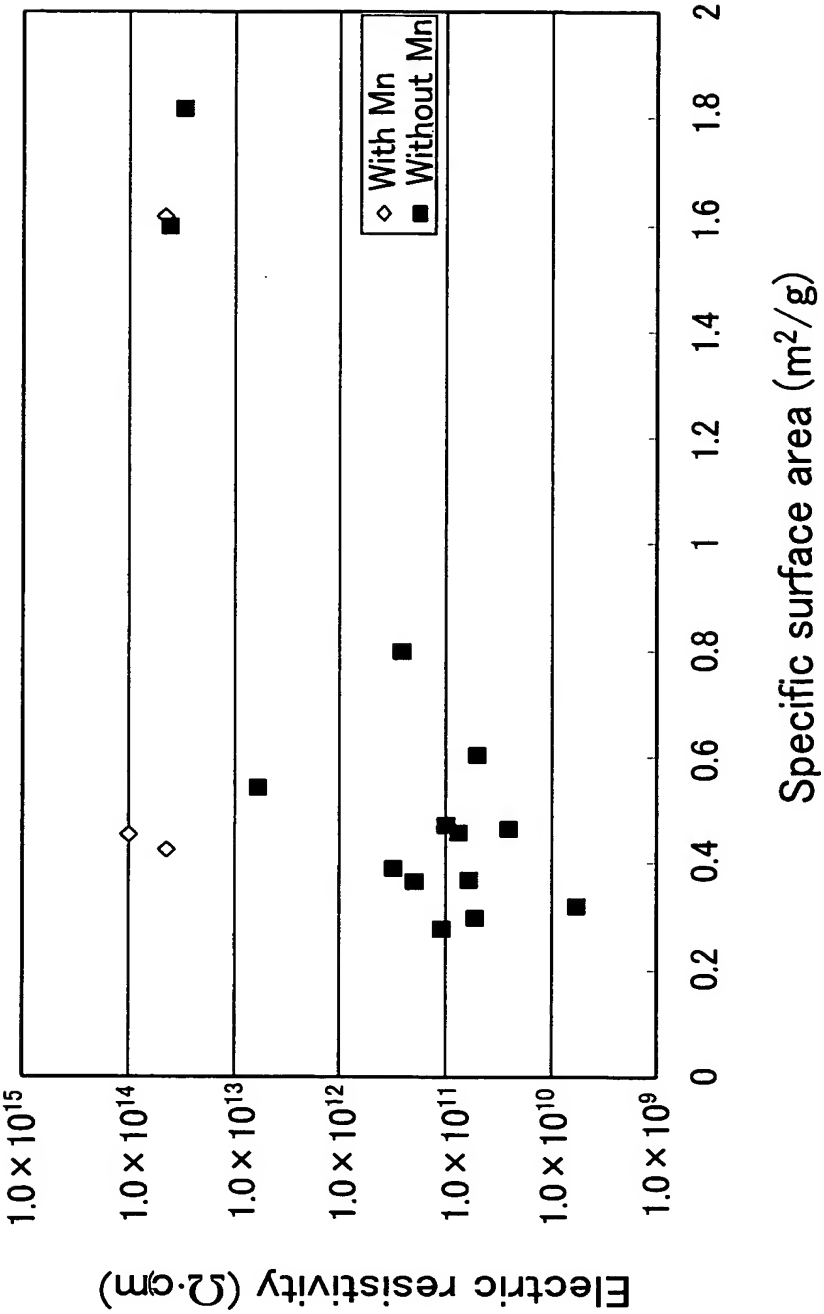

Electric resistivity (Ω·cm)
1.0 × 10^15
1.0 × 10^14
1.0 × 10^13
1.0 × 10^12
1.0 × 10^11
1.0 × 10^10
1.0 × 10^9
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Specific surface area (m²/g)
With Mn
Without Mn

Figure 15A
Crushed powder

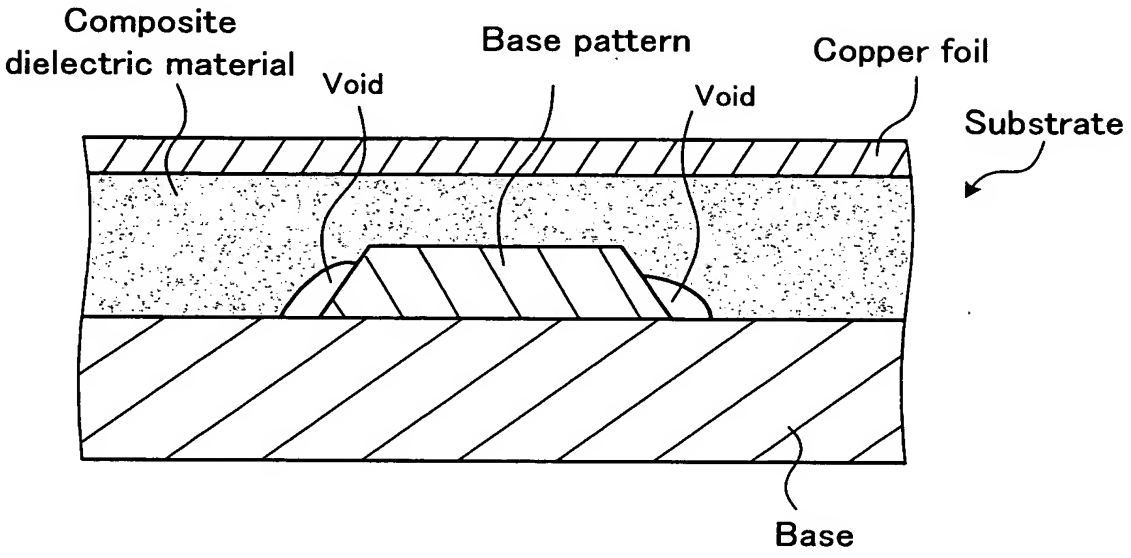


Figure 15B
Spherical powder

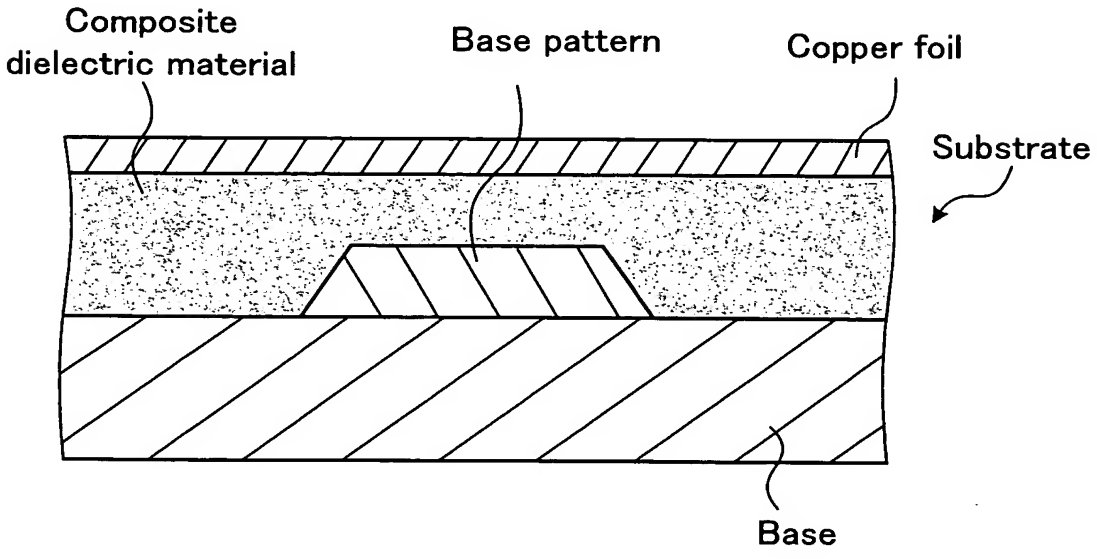


Figure 16

Annealing (°C)	Dielectric properties (at 2 GHz)		Insulation resistance	Remarks
	ε	Q	Electric resistivity (Ω · cm)	
1000	11.76	359	4.5×10^{13}	$MnCO_3$ added when mixing